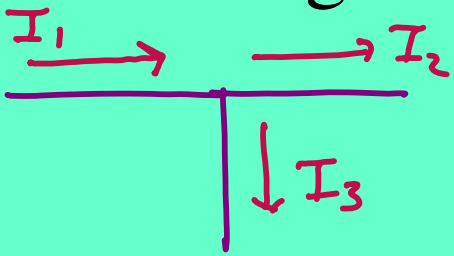
Kirchhoff's Rules

"This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us." -- Western Union internal memo, 1876.

Kirchoff's Rules

- Often we cannot simplify a circuit into just one loop. We then use Kirchoff's Rules:

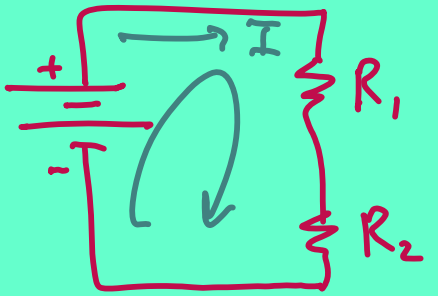
1. The sum of the currents entering any junction in a circuit must equal the sum of currents leaving that junction (Conservation of charge).



$I_{in} = I_{out}$; $I_1 = I_2 + I_3$

2. The sum of the potential difference across all elements around any closed circuit loop must be zero (conservation of energy).

$\sum_{loop} \Delta V = 0$ $\quad \mathcal{E} - IR_1 - IR_2 = 0$



Sign Conventions

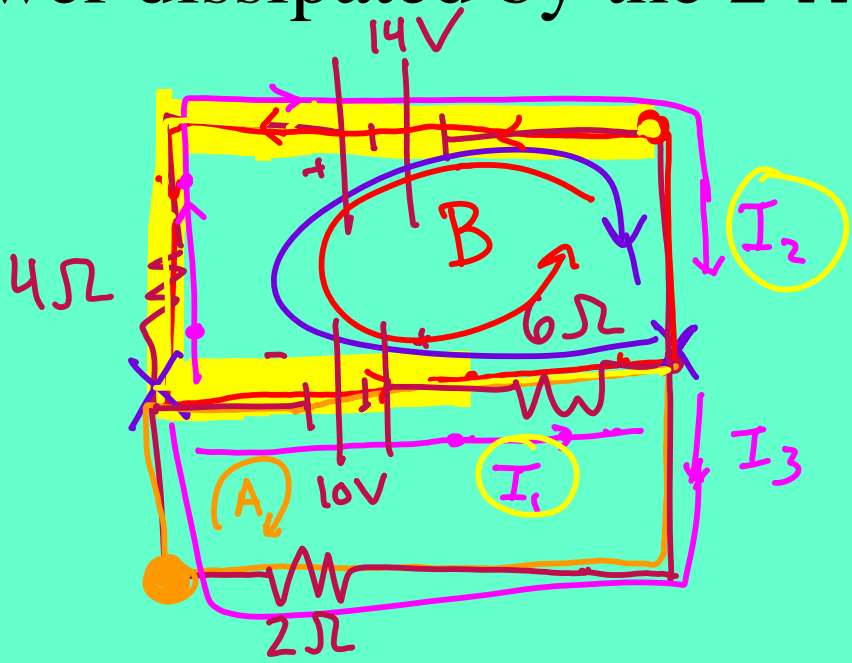
1. If you encounter the (–) terminal of the battery first, you add the voltage of the battery.

2. If you are going the same direction as the current across a resistor, you subtract

   IR

Example

1. Find the current through each resistor in the circuit that Mr. Waechtler draws.
2. Find the potential difference across the 4 Ω resistor. $\Delta V = IR = 3(4) = 12\,V$
3. Find the power dissipated by the 2 Ω resistor. $P = I^2R$ $P = 1^2(2) = 2\,W$



$I_{in} = I_{out}$

$I_1 + I_2 = I_3$ (1) ✓

A: $10 - 6I_1 - 2I_3 = 0$ (2) ✓

B: $14 + 4I_2 + 10 - 6I_1 = 0$ (3) ✓

$I_1 = 2A,\ I_2 = -3A,\ I_3 = -1A$ ✓